Department of Fish and Game, Water Branch
Responses to PREs ***rationale for changing the X2 standard*** (March , 2009)

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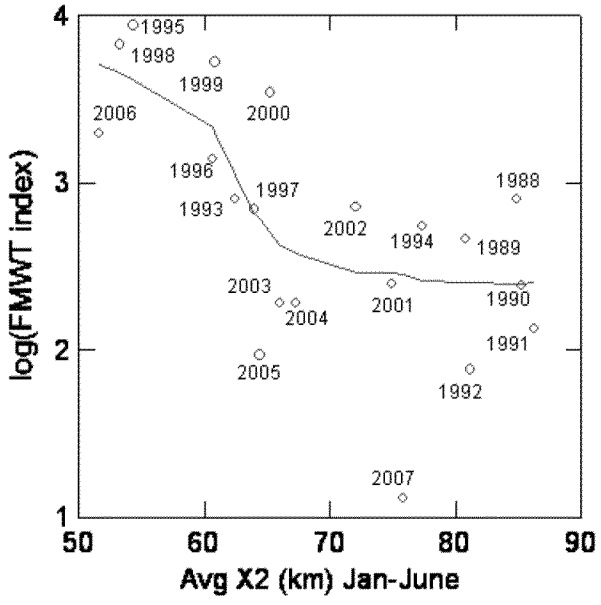
Summary of rationale for the Roe Island trigger

The X2 standard is a water quality objective for the San Francisco Estuary intended to protect a suite of beneficial uses. Only one of its originally intended purposes was to "generate" higher abundance of ESA-listed fishes *in the Delta*.

It is correct that the X2 standard is based on correlations involving long averaging periods and the exact amounts of flow needed to produce particular benefits for the estuary are not known. However, the attached plot shows one example of why a Roe Island standard is probably important. The plot shows the relationship between longfin smelt abundance and X2 in the post-Corbula years. The spline is a LOWESS regression line (default settings in SysStat, so the shape of the curve was not pre-judged). It implies that X2 at or downstream of Roe Island (65 km) is required to produce a detectable abundance increase.

We note that there was no references cited section in this rationale for us to determine what embedded references were referring to.



1. **X2, as an indicator of species abundance, correlates significantly with 2 covered and 3 non-native fish species**:

Bay shrimp, starry flounder, longfin smelt, splittail, bay goby, Pacific sanddab, and shiner surfperch are all native species. Only striped bass and American shad are non-natives. The following is the latest list of species with significant correlations to X2 (Kimmerer et al. 2009 in their Table 2):

- Bay shrimp
- Starry flounder
- American shad
- Longfin smelt
- Splittail
- Striped bass survival
- Bay goby
- Pacific sanddab
- Shiner surfperch

It is likely that a comprehensive evaluation would reveal that more species abundances correlate with flow – particularly since nearly all extant native species reproduce during winter-spring and many have better reproductive outputs when flows are high.

With regard to bullet 'c' in the rationale, DFG and other biologists are not convinced that Kimmerer's method of testing for a habitat effect on abundance is valid. The main reason for our concern is that habitat is almost certainly limiting at high X2, but may reach a point that it isn't limiting at lower X2. Thus, habitat limitation could be a mechanism at high X2 that is "relieved" at some point when high flows push X2 further downstream. Additionally, the number of eggs, larvae, and juveniles actually present during a particular flow event (partly a function of prior year class strength) is also going to affect how "full" a volume of habitat is at any given time. Striped bass survival is the only response variable that addresses this and it did show evidence of a significant flow-habitat connection.

Feyrer et al. (2007) also showed that salinity contributes to habitat space for striped bass and delta smelt. This study occurred during fall, but shows a linkage between habitat area and fish catches under typically low flow conditions because fall is a comparatively dry time of year on average.

2. **X2 is not a mechanism driving fish species abundance**:

a. The statement is correct, but X2 was intentionally designed as an indicator of a suite of mechanisms that do contribute to variation in fish species abundance (Jassby et al. 1995).

b. True.

c. This statement is not correct – the area or volume of suitable low-salinity spawning and/or rearing habitat or some level of habitat suitability are among the mechanisms implied, which is why Kimmerer et al. (2009) was written.

d. Correct – except that we disagree with the American shad mechanism proposed by Kimmerer (2002). We think it is more likely that X2 is a surrogate for tributary and Sacramento river flows during the shad's late spring and early summer spawning season, which increases habitat area and improves age-0 transport to and through the estuary.

e. This is the hypothesis that is currently best supported by data. Other covarying mechanisms also may be important.

f. We are not certain what point is intended here. It is widely acknowledged, including in statements in the rationale preceding this one, that X2 mechanisms vary among species. The statement does not seem relevant. Further, there is always "scientific uncertainty," but the lack of a scientific finding regarding a phenomenon that is currently under study does not mean a mechanism or mechanisms do not exist.

3. **Roe Island is triggered infrequently but can be costly**:

a-c. This is the case because the X2 standard is trying to mimic a natural (unimpaired) hydrograph because that was an important aspect of the ecological system the estuary's species assemblage evolved in.

d. The input data and techniques used to generate this plot are not described. We are not sure of the relevance of the graph to the topic. X2 at Roe Island is met with outflow of 29,200 cfs. Nothing to the left of the 70% exceedance flow value is being managed.

e. This analysis uses Kimmerer's linear model, which is used for simplicity's sake to approximate a response across species using a common methodology. As we've shown above, the relationship between X2 and longfin smelt abundance since the introduction of the overbite clam is not linear. It is a step increase with X2 near Roe Island as the change point. Thus, this analysis is oversimplifying the cost-benefit of flow for longfin smelt. Given its current low abundance, it would not be prudent to change one manageable factor we can demonstrate makes a population dynamic difference until we better understand the proposed action and its consequences and unless and until other actions have been documented to improve abundance.

g. This document indicates that reservoir releases (or less pumping) would have been needed to meet Roe Island in 7 percent of all years. But X2 at Roe Island would not be triggered at all in many of the 82 years so these 6 years would be a larger percentage of years when Roe actually was triggered.

Further, these two plots seem to contradict the plot shown to support bullet 'd'. These suggest that the Roe Island trigger only costs project water in 7% of years. However, the plot for bullet 'd' shows a difference in X2 from 70% to 30% exceedance, which would presumably be about 40% of years.

"Maintaining the Roe Island standard beyond that supported by naturally occurring hydrology depletes upstream storage that could otherwise have been used to contribute to other planning goals."

This is an odd sentence. The "naturally occurring hydrology" would not be captured in reservoirs. One point of the X2 standard was to recreate a semblance of the "naturally occurring hydrology."

4. **Uncertainty regarding the benefit of X2 and other plausible mechanisms**:

a. This statement is and always will be true – but the lack of full scientific understanding of exactly how flow 'works' for a suite of species should not be confused with the documented scientific understanding that *flow does beneficial things for the estuary* (Jassby et al. 1995; Kimmerer 2002; Kimmerer et al. 2009).

b. The linkage of the statement to X2 as an estuarine management tool is nebulous. These statements have tended to reflect a feeling that too much emphasis is placed on fish entrainment. It is true that better understanding of mechanisms might eventually lead to different and more strategic management of the estuary. However, until that information exists, it makes sense to provide the estuary with a flow regime that resembles what the local fauna evolved with and are adapted to.

c. The overview is correct, but this assessment ignores the idea of "multiple interacting factors" alluded to in the previous bullet. The underlying X2 mechanism that existed pre-clam is very likely still operating, which is why longfin smelt still show a flow-abundance relationship (Kimmerer 2002). Sitting on top of that is chronic food limitation caused by the overbite clam, which has lowered longfin smelt carrying capacity. Still other mechanisms also may be contributing in recent years. However, it does not follow that because there is chronic food limitation of longfin smelt now that they are no longer in need of whatever more fundamental benefit X2 (outflow) provides them.

d. We do not understand the relevance since X2 is a manageable flow tool that encompasses all of the potential energy, transport flows, etc. that covary with it (Jassby et al. 1995).

e. The floodplain spawning mechanism only applies to splittail, which are known to spawn most successfully on floodplains (Sommer et al. 1997). The currently accepted conceptual model for estuarine habitat is that both the flow/water quality and the structural aspects of fish habitat have to overlap to generate fish production zones (Peterson 2003). Thus, a tidal marsh can only be useful given

two conditions 1) fish will enter the marsh channels or at least aggregate near them to take advantage of exported prey production, and 2) flows generate the proper water quality conditions in and near the tidal marsh to support the target fish.

f. We do not believe the first statement is relevant. It is well-known that inflows, outflows, and X2 are highly correlated – in fact the document states this in f.$_{ii}$. The species shown to respond to X2 include species that occur upstream of the Delta, in the Delta, and downstream in the bays. Thus, there can be no question that *both* inflows and outflows are necessary to produce the abundance responses for such a diverse suite of species. We do not understand the point that is being made about unimpaired flow overestimating "natural flow." Further, quoting a 1956-present "average" proportion of inflow that becomes outflow is misleading given the substantial increase in Delta exports that occurred in this long averaging period and the substantial number of very high winter-spring outflow years that dilute the point of the Roe Island standard. The Roe Island standard is intended to provide closer to historic Delta outflow in the wetter periods during average years, not very wet years.

g. This is a very strong conclusion with no statement of what is meant by 'variability' (e.g., how much variability in which water quality parameters at what times of year) and no supporting references.

h. The correlation mentioned in the first sentence should be referenced. To our knowledge, no peer reviewed studies have established a strong relationship between ammonia throughout the Delta and X2. The statement concerning the increase in ammonia rising in the Delta is not substantiated. Our cursory review of the data indicates that ammonia-N has remained relatively constant at many locations over the last 10 years. Dugdale's published research has identified the inhibitory effect of ammonia on phytoplankton in Suisun Bay. Recent and yet to be published work related to algae growth in the Sacramento River did not show the inhibitory effect of ammonia that was observed in Suisun Bay.

i. Regarding (i), the overbite clam grazes the existing standing stock of phytoplankton and copepod nauplii. Faster production during winter-spring might generate more feeding opportunities for larval native fishes before the clam's metabolism ramps up each summer. To this point the rationale has had a "correlation is not causation" theme but culminates with correlation based on a reasonable, but unproven food web linkage. Note the foodweb linkage is not supported for delta smelt or splittail and is only part of the mechanism for longfin smelt since its X2-abundance slope did not change following the overbite clam invasion (Kimmerer 2002). We agree on h.$_{iii}$ if the proposed hypothesis is correct, though we are uncertain what was meant by "proxy correlation." However, this simple food chain explanation is not supported by the data available presently – both Kimmerer (2002) as cited above, and the preliminary Dugdale work for the Sacramento River near the treatment plant outfall.

Modification of the Collinsville standard

The rationale is not developed for this sub-proposal. The Bay-Delta WQCP already provides that if the water year is very dry through April, the X2 concept is discarded in May and June in favor of a fixed minimum outflow requirement (4000 cfs) that is substantially less than the flow equivalent to X2 at Collinsville (7100 cfs). We are very interested to understand the form of relief is contemplated by the authors.

References

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